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Authors

Hoyt, Lindsay
Maslowsky, Julie
Olson, Julie
et al.

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Adolescent Sleep Barriers: Profiles within a Diverse Sample of Urban Youth

Lindsay Till Hoyt[1], **Julie Maslowsky**[2], **Julie S. Olson**[3], **Allison G. Harvey**[4], **Julianna Deardorff**[5], **Emily J. Ozer**[5]

[1]Department of Psychology, Fordham University, Bronx, NY, USA

[2]Department of Kinesiology and Health Education, University of Texas, Austin, TX, USA

[3]Carolina Population Center, University of North Carolina, Chapel Hill, NC, USA

[4]Department of Psychology, University of California, Berkeley, CA, USA

[5]School of Public Health, University of California, Berkeley, CA, USA

Abstract

Most adolescents face numerous obstacles to good sleep, which may undermine healthy development. In this study, we used latent class analysis and identified four categories of sleep barriers in a diverse sample of 553 urban youth (57% female). The majority profile, *School/Screens Barriers*, reported the most homework and extracurricular barriers, along with high screen time. The Home/Screens Barriers class (i.e., high environmental noise, light, screen use) and the *High/Social Barriers* class (i.e., high barriers across domains, particularly social) reported the poorest sleep quality and highest depressive/anxiety symptoms. The *Minimal Barriers* class—predominately male, with low depressive/anxiety symptoms—reported more sleep per night. We discuss implications of our findings for targeting interventions to address poor adolescent sleep among specific clusters of students.

Keywords

Adolescent health; Sleep barriers; Latent class analysis; Urban youth

✉Lindsay Till Hoyt, lhoyt1@fordham.edu.

Authors' Contributions L.T.H. designed the current study, participated in data collection, analysis, and interpretation, and drafted the manuscript; J.M. participated in the design of the current study, interpretation of the analysis, and helped draft the manuscript; J.S.O. performed the statistical analysis and helped draft the manuscript; E.J. O. and A.G.H. designed and led the larger intervention study and provided critical revisions of the manuscript. J.D. participated in the study design and provided critical revisions of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest The authors declare that they have no conflict of interest.

Compliance with Ethical Standards

Ethical Approval All procedures involving human participants were in accordance with the APA Ethical Standards in the treatment of the participants and approved by the Institutional Review Board at the University of California, Berkeley.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Introduction

Adolescence is characterized by normative biological and social changes associated with the irregular timing and reduced duration of sleep. Later bedtimes combined with earlier school start times often mean that, as adolescents mature, they sleep less than they did before high school (Carskadon 2011). Youth also display greater tolerance for sleep deprivation with age, which may allow adolescents to stay up later, regardless of their levels of daytime sleepiness (Dahl and Lewin 2002). Experts from the American Academy of Sleep Medicine (Paruthi et al. 2016) and the National Sleep Foundation (Hirshkowitz et al. 2015) suggest that youth need around 8–10 h of sleep, yet less than 30% of high school students in the United States (U.S.) get 8 or more hours of sleep on weeknights (Kann et al. 2016), with similar estimates from other countries (Gradisar et al. 2011).

Chronic, insufficient sleep can have serious negative implications across all areas of youth development including psychological well-being (Danielsson et al. 2013; Fuligni and Hardway 2006), poor academic performance (Roberts et al. 2009), reduced neurobehavioral functioning (Sadeh et al. 2003), higher delinquency (Clinkinbeard et al. 2011), and substance use (Pasch et al. 2012). There is also substantial evidence linking short sleep and physical health in adolescence, including obesity (Cappuccio et al. 2008) and inflammation (Park et al. 2016). Interestingly, research suggests that most youth recognize the negative repercussions of poor sleep. For example, in one study of three Midwestern high schools, students reported that not getting enough sleep had the following effects on them: daytime sleepiness (93.7%), difficulty paying attention (83.6%), lower grades (60.8%), increased stress (59.0%), and problems getting along with others (57.7%) (Noland et al. 2009). Despite these insights, youth struggle to change their sleep behaviors so as to obtain more sleep. Further, there is limited evidence for successful sleep interventions to date (Cassoff et al. 2013; Tavernier and Adam 2017).

Biologically-driven developmental processes, such as the reorganization of the circadian sleep-wake cycle (i.e., delayed sleep phase; the natural tendency for later bedtimes and wake times), and the steep decrease in delta slow-wave sleep (i.e., deep sleep) across adolescence, are not easily malleable. Therefore, identifying social, contextual, or behavioral barriers to good sleep represents an important pathway towards promoting healthy youth development. Throughout the high school years, adolescents experience increasing autonomy from parents (who often set childhood bedtimes), more freedom to socialize with peers into the evening (either in person or electronically), and increasing responsibilities in the home and at school (e.g., work, extracurricular activities), which may alter sleep patterns (Carskadon 2011). Therefore, as young people take more responsibility over their own sleep, it is important to understand which factors youth identify as barriers to getting enough sleep, and how these factors differ across diverse groups of adolescents.

Barriers to Adolescent Sleep

When youth report on what prevents them from getting enough sleep, most high school students identify homework as a primary barrier, followed by stress, television viewing, and socializing with friends (Noland et al. 2009). Overall, these themes identified by youth (i.e., homework, stress/worry, technology use, socializing) align with survey and

ecological momentary assessment studies of key sociocultural and psychological barriers to sleep during adolescence (Bartel et al. 2015). Although not as readily reported by (and perhaps less obvious to) youth and families, environmental factors such as noise exposure (Vollmer et al. 2012), outdoor light at night (Passchier-Vermeer and Passchier 2000), and neighborhood disruptions (Heissel et al. 2017) may also be important sleep barriers to consider.

Parents, teachers, and policymakers often point to increased screen time and electronic media use as key barriers to adolescent sleep. A review of 36 studies concluded that electronic media use was consistently associated with delayed bedtime and shorter total sleep time among school-aged children and adolescents (Cain and Gradisar 2010). The U.S. National Sleep Foundations poll (2014) found that most parents (75–80%) now have technology curfews for their children and adolescents' phones, computers, television, and video game usage (although they are strictly enforced only around 35–59% of the time). The same study found that most 15–17-year-old youth have three electronic devices, on average, in their bedroom; the most common devices include televisions, computers, smartphones, video games, and MP3 or other music players.

The displacement hypothesis (Van den Bulck 2004) argues that technology use displaces sleep by delaying bedtime. Additionally, some studies suggest that technology use increases physiological arousal in the evening, reducing the body's preparedness for sleep (Weaver et al. 2010); or that the bright light from screens potentially decreases evening levels of melatonin, making it harder to fall asleep (Wood et al. 2006). However, other research suggests that screen time and social technology influences on sleep are more complicated than originally proposed. For instance, a recent meta-analysis found that the correlation between technological devices and adolescent sleep was negligible (Bartel et al. 2015). Additionally, a longitudinal study suggests that sleep problems predicted longer time spent watching television and on social networking sites, but not vice versa (Tavernier and Willoughby 2014). Indeed, for youth suffering from sleep problems related to stress or anxiety, technology use may fill the void while they wait until they feel able to sleep (i.e., distracting themselves with a screen, rather than ruminating about past events or worrying about the future) (Bartel and Gradisar 2017). That is, electronic media and screen time may have differential effects on sleep for different subgroups of youth that is overlooked in medical research where much of the evidence on youth sleep is published.

While previous research has identified many potential barriers to sleep among youth, most research to date focuses on a single factor at a time (e.g., screen time or negative home environment). Few empirical studies examine *multiple* barriers simultaneously, such that patterns can be observed. In one notable exception, a study using a large, nationally representative sample of children aged 5–19 found that sleep behaviors were influenced by a combination of demographic variables, structural factors (e.g., school start times, travel time to school), child activity choices (e.g., watching television, homework, extracurricular activities), and family functioning (Adam et al. 2007). In order to consider interventions and policies to promote positive sleep, it is important for developmental scientists to explore the nuances and multidimensional elements of adolescent sleep – building upon foundational research from sleep labs and medical studies – to understand how diverse youth experience

social, academic, and contextual influences on their sleep in their daily lives. The current study contributes to this literature, taking a person-centered, ecologically valid approach to investigate unique patterns of sleep barriers among diverse, high school youth today.

Individual Differences in Adolescent Sleep

While most youth experience some barriers to getting sufficient sleep, the quantity and severity of those barriers (e.g., homework, screen time, neighborhood) may depend on a number of factors. Demographic characteristics, such as female gender and racial/ethnic minority status (Maslowsky and Ozer 2014) or low socioeconomic status (SES) (Marco et al. 2012), are related to shorter sleep duration. Less is known about differences in barriers to sleep that are experienced by members of diverse demographic groups. Some research suggests that features of the home and/or neighborhood environments that are likely correlated with SES may lead to sleep problems for adolescents, either directly (e.g., noise, outdoor light) by increasing sleep onset latency or causing mid-night waking (Vollmer et al. 2012), or indirectly (e.g., violence, safety fears) due to increased stress (Heissel et al. 2017; Singh and Kenney 2013).

There is also a substantial body of work linking adolescent stress and anxiety with sleep onset delay (Sivertsen et al. 2015) or short sleep (Doane and Thurston 2014; Fuligni and Hardway 2006) during adolescence. Relatedly, “Type D” personality (i.e., distressed personality, characterized by negative affectivity and social inhibition) is also related to sleep problems and short sleep in adolescence (Condén et al. 2013). From a developmental perspective, substantial cognitive changes during adolescence mean that stress and worry are more likely to interfere with sleep onset during adolescence than in childhood (Dahl and Lewin 2002).

Individual differences in sleep characteristics (i.e., sleep duration, sleep quality, and attitudes towards sleep) may also be associated with distinct sleep barriers. For example, youth who report short sleep, perhaps due to late bedtimes, may report barriers such as homework or screen time, while youth who report poor sleep quality (e.g., problems staying asleep) may be more likely to report environmental noise or stress. Further, those who value sleep may identify different barriers than those who do not think sleep is important. However, these nuances have been understudied in the sleep literature. Finally, the presence or absence of parental rules about sleep (i.e., bedtime, electronic curfew) may have important, direct effects on specific, youth-reported barriers.

Current Study

To address these gaps, in the present study, we used a person-centered analytic approach to answer two research questions: How do adolescent-reported reasons for poor sleep co-occur within individuals (Research Question 1), and Do adolescents who experience each of the sleep barrier profiles differ in sociodemographic features, neighborhood stress, depressive and anxiety symptoms, and sleep characteristics (Research Question 2)? Whereas variable-centered approaches focus on examining relations among variables across individuals, person-centered approaches identify distinct sub-groups of people based on their similarities on a set of variables (Laursen and Hoff 2006). The majority of previous studies have used

variable-centered analytic procedures that typically examine only one dimension of sleep barriers (e.g., homework, screen time, noise in the home). A person-centered approach provides an ecologically valid manner of describing categories of co-occurring sleep barriers and characterizing the adolescents who experience each cluster of sleep barriers.

No prior research to our knowledge has examined the clustering of sleep barriers among adolescents; therefore, we propose both specific and exploratory hypotheses. Our hypotheses for Research Question 1 were based on previous studies of the prevalence of individual sleep barriers. We predicted that most adolescents would fall into a normative class, experiencing typical barriers reported in previous research (e.g., Bartel et al. 2015), such as homework, socializing, and screen time (Hypothesis 1). We also expected to find a class of youth with elevated environmental barriers to sleep (Hypothesis 2), based on research showing that noise and light have direct effects on youth sleep (e.g., Vollmer et al. 2012). With regards to Research Question 2, we hypothesized that youth with higher average levels of neighborhood stress will report more environmental sleep barriers (Hypothesis 3), given research that living in dangerous or unsafe neighborhoods may affect sleep practices in adolescence (e.g., Heissel et al. 2017). Further, we expected that youth with high levels of depressive and/or anxiety symptoms would report more sleep barriers across *all* categories (Hypothesis 4). As mentioned previously, stress is related to longer sleep latency, and youth may actively seek out activities to fill the void while they wait until they feel able to sleep: therefore, youth with higher depressive or anxiety symptoms may report high, unspecific barriers across all domains. Finally, we will examine how clusters of sleep barriers among youth relate to other sociodemographic (i.e., age, gender, race/ethnicity), neighborhood, and sleep-specific characteristics. We do not offer specific hypotheses here, given the lack of previous research on sleep barriers; rather, the goal of these additional analyses is to explore how these classes are distributed across a diverse sample of youth, and how these multidimensional characterizations of sleep barriers relate to sleep duration, quality, attitudes, and rules. Overall, this study seeks to contribute to the field's understanding of the clustering of barriers to sleep, with implications for the targeting of interventions intended to address barriers to sleep among adolescents.

Methods

Data and Sample

Data were drawn from the baseline survey conducted during 2015–2016 in four diverse Northern California high schools as part of a five-session sleep intervention study. High schools were selected to maximize participant diversity in race/ethnicity, SES, and neighborhood disadvantage. The design involved within-school randomization by class period in required health or career classes, therefore providing a broad representation of students within their grade, as opposed to students in an elective (i.e., self-selecting) class or an academic class based on academic ability. Additional information about the intervention study can be found in Gaarde et al. (2018). The baseline survey focused on assessing self-reported adolescent sleep, health behaviors, and overall well-being.

Participants in the main study included 734 9th–12th grade students who provided active assent and parent/guardian consent and then completed a survey. Given our focus on poor

sleep, the current study included only those respondents who agreed with the statement "I don't get as much sleep as I'd like on school nights" ($N = 556$) and then answered a set of questions regarding why they did not get as much sleep as they would like. Three respondents were excluded from the sample because they skipped the entire set of follow-up questions. The final analytical sample included 553 respondents (57% female; 67% in 9th grade and 11% in each of 10th, 11th, and 12th grades; 31% White/Caucasian, 5% Black/African American, 24% Asian American, 12% Hispanic/Latino, 27% mixed ethnicity, 1% other ethnicity), between the ages of 13–19 years old ($M = 14.76$, SD = 1.06). Measures of individual level SES were not permitted per school district research guidelines, however, schools in the sample had a large proportion of adolescents living in low-income households, as evidenced by the range of students eligible for free/reduced lunch (ranging from 44.6–75.3% across schools). The analytic sample included a higher proportion of females compared to the full sample (57 versus 44%; $t(693) = -2.65$, $p < .01$), but there were no differences in race/ethnicity or age.

Measures

Reasons for poor sleep

Respondents who reported not getting as much sleep as they would like were prompted to answer 14 questions probing for reasons for their poor sleep. These items were dichotomized such that respondents who answered sometimes, often, or always experiencing a given sleep distraction were coded as 1, whereas respondents who answered never experiencing that sleep distraction were coded as 0. The 14 items included: noise in the home; noise in the neighborhood; light in the respondent's room; late dinner; homework; starting homework late; extracurricular activity; socializing with friends; socializing with relatives; work after school; family members who stay up late; socializing online; watching television shows; and having a pet keep them awake at night. Barriers were derived from a review of the literature and then vetted for completeness via a consensus process from our team of adolescent sleep experts. These items were combined using latent class analysis (described in the Analytical Plan).

Sociodemographic characteristics

Adolescents reported their gender as male, female, or other. Those who reported "other" were dropped from analyses involving gender given the small sample size ($n = 8$) and gender was dichotomized such that female = 1 and male = 0. Age was measured continuously (ranging from 13–19 years old) based on adolescent self-report. Students reported on their own race/ethnic identity. For analytic purposes, these data were re-coded into six major ethnic groups for the current study: Hispanic/Latino, White/Caucasian, Black/African American, Asian American, other race/ethnicity, more than one race/ethnicity.

Neighborhood stress

In order to capture SES-related stressors related to adolescents' neighborhood environments, we used an average of all six items from the Neighborhood Microsystem subscale (being scared by someone; being approached by a drug dealer; living in a mostly noisy neighborhood; not having a place to hang out; seeing homeless people; not having a way

to earn money) from the Daily Hassles Microsystem Scale (Seidman et al. 1995). For every item that occurred in the last month, youth rated the severity from 1 “not at all a hassle” to 4 “a very big hassle,” non-endorsed events were coded as 0. This scale demonstrated good internal consistency in our sample (α= .80).

Depressive symptoms

Depressive symptoms were assessed by taking the mean of 10 items from the short version of the Center for Epidemiological Studies Depression Scale (Radloff 1977). Participants answered “How often was the following true during the past 7 days?” from 0 (never or rarely) to 3 (most of the time or all of the time): felt blue; bothered by things that do not usually bother you; felt depressed, had trouble keeping mind on things; did not enjoy life; did not feel happy; did not feel just as good as other people; felt disliked by people; felt sad; and felt too tired to do things (never/rarely; sometimes; a lot of the time; most/all of the time; α= .74).

Anxiety symptoms

Anxiety symptoms were assessed by taking the mean of 21 items from the Multidimensional Anxiety Scale for Children (Reynolds and Richmond 1978), including the physical (e.g, tense/uptight, shaky/ jittery) and social (e.g., feel strange, worry about what people will think) anxiety sub-scales reported on a scale from 0 (never true about me) to 3 (often true about me). The full scale demonstrated good internal consistency (α= .94).

Sleep duration, quality, values, and parents’ rules

Sleep duration was operationalized as hours of sleep per night, a continuous variable based on respondent self-report of average hours of “actual sleep” on school nights over the past week. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), which includes questions on sleep latency, efficiency, daytime dysfunction, and sleep disturbances and demonstrates adequate reliability and validity in adolescent populations, with a score greater than 5 indicating poor quality (de la Vega et al. 2015). Respondent attitudes about sleep were captured using a dichotomous indicator of whether the respondent agreed or strongly agreed with the statement “I think that getting enough sleep is very important” (versus those who disagreed or somewhat agreed/disagreed). Finally, to determine sleep rules we analyzed (separately) one question to designate a set bedtime, “Do your parents/ guardians set a bedtime on school nights?” and one question to indicate an electronic curfew, “On school nights, do you have a rule or set time in your house about when you are supposed to turn off or put away computers, phones, or other electronics?” (0 = no, 1 = yes).

Analytical Plan

Latent class analysis (LCA) is a type of finite mixture model that characterizes measured variables into classes that are not directly observed (i.e., latent) but can be defined by observed variable response patterns (Collins and Lanza 2013). Here, LCA was used to group individuals according to their reported reasons for having poor sleep. LCA was performed using Mplus statistical software version 7.4 (Muthén and Muthén 1998–2015). Full information maximum likelihood (FIML) was used to handle missing data. FIML estimates

exogenous variance to avoid listwise deletion, such that all cases were retained even if they were missing on individual indicators of poor sleep. We determined the appropriate number of latent classes in our analytical sample by evaluating both interpretability and several fit statistics, including a log-likelihood test, Bayesian information criteria (BIC), and sample-size-adjusted BIC (ABIC). For these criteria, smaller absolute values indicate better model fit; thus, the relative change from the k class to $k-1$ class is important in assessing fit. We further evaluated the Lo-Mendell Rubin (LMR) adjusted likelihood ratio test; a significant LMR p-value suggests that the k class model fits better than the $k-1$ class model. Finally, we considered the entropy statistic, which ranges from 0 to 1 with larger values indicating clearer distinction between latent classes.

Once classes were identified with LCA, our second analytical step was to test for differences in sociodemographic characteristics, depressive and anxiety symptoms, and sleep attitudes and quality across latent classes. We used one-way ANOVA tests to determine significant between-class differences, and independent samples t-tests to evaluate specific class comparisons.

Results

Table 1 displays the fit statistics that we evaluated to determine the appropriate number of latent classes among respondents in our sample. Based on the relative decrease of loglikelihood, BIC, ABIC, and interpretability, a four-class solution provided the most adequate fit of the data. The entropy of the four-class solution was greater than 0.8, indicating clear distinction between latent classes. The LMR p-value, furthermore, was statistically significant, though only marginally ($p < .10$). In addition to model fit, the four-class solution was more clearly interpretable than the three-class solution (which also had acceptable fit). In the three-class solution, two of the classes from the four-class solution, *School/Screens Barriers* and *Home/Screens Barriers*, described below, were combined into one large class. We found the distinction between these two classes to be substantively meaningful given prior literature highlighting potential differential contributions of academic and environmental barriers to sleep. The combination of improvement in both fit indices and interpretability led us to choose the four-class solution, which presented substantively meaningful and useful clusters, with a suitable number of respondents in each class. Descriptive statistics for the full sample and for each class are presented in Table 2, and Fig. 1 depicts the percentage of respondents reporting each reason for poor sleep by class membership. Results from one-way ANOVA tests suggested significant differences ($p < .001$) between classes for all 14 reasons adolescents report getting poor sleep.

Research Question 1: Clustering of Sleep Barriers

Classes were labeled based on the patterns of reasons for poor sleep observed in each (see Fig. 1). The first class, *School/Screens Barriers*, was the majority class, with 62% of our sample falling into this class. The defining characteristics of this class were the highest frequency of getting poor sleep due to homework (93%), starting homework late (88%), and

extracurricular participation (78%), as well high levels of screen time, including watching show (82%) and socializing online (75%).

The second class (15% of respondents) was labeled *Home/Screens Barriers*, given the highest frequency of respondents who reported noise in home (94%) and neighborhood (47%), and relatively high score for light in the room (46%) and family members up late (74%), while also reporting substantial screen use (81% watching shows; 74% socializing online). This class had similar levels of screen use as the *School/Screens Barriers* class but emerged as a distinct class due to the co-occurrence of screen use barriers with environmental distractions (*Home/Screen Barriers*) versus academic distractions (*School/Screen Barriers*).

The third class was named *Minimal Barriers*. This class comprised nearly 13% of the sample and stood out as having consistently lower than average frequency of all fourteen reasons for poor sleep. The final class of respondents, labeled *High/Social Barriers*, comprised 9% of our sample and was characterized by consistently high proportions of respondents reporting each reason for poor sleep (i.e., higher than 40% except the question about neighborhood noise; 100% starting homework late, engaging in extracurricular activities, socializing with friends, socializing online, and watching shows as reasons for poor sleep). Further, this class demonstrated the highest levels of barriers with a direct (e.g., socializing with friends/family/online) or indirect (i.e., extracurricular activities, work after school) social interaction.

Research Question 2: Characteristics of Sleep Barrier Classes

The *Minimal Barriers* class was predominantly male (65%); there were no other statistically significant differences in gender. The *Minimal Barriers* class had the highest percentage of Hispanic/Latino youth (21%). The *Home/Screens Barriers* class was the most likely to be Asian American and least likely to be White/Caucasian. One-way ANOVA indicated that between-class differences in neighborhood stress and both depressive and anxiety symptoms were statistically significant ($p < .001$). The *Home/Screens* and *High/Social Barriers* classes had highest levels of neighborhood stress, anxiety, and depressive symptoms), significantly more than both the *School/Screens Barriers* and *Minimal Barriers* classes (see Table 2).

Between-class differences in sleep duration ($p < .001$), sleep quality ($p < .001$), sleep values ($p < .05$), and sleep rules ($p < .05$) were also statistically significant. The *Minimal Barriers* class reported the most sleep hours per night (7.75), the lowest frequency of respondents with poor sleep quality (20%), and the highest frequency of electronic curfews, (44%), significantly higher than the other three classes. The *Home/Screens* class reported the lowest typical amount of sleep per night (6.87 h) and exhibited the highest class-specific frequency of poor sleep quality (60%), which was significantly higher than *School/Screens* and *Minimal Barriers classes*. The *Home/Screens Barriers* class also reported significantly lower sleep duration than the *Minimal Barriers* class and significantly higher sleep values than the *High/Social Barriers* class. Finally, the *School/Screens Barriers* class reported the highest class-specific frequency of thinking sleep was important (85%), followed by the *Home/Screens Barriers* (82%). The *Minimal Barriers* (75%) and *High/Social Barriers* (69%)

classes had significantly lower class-specific frequencies of young people who thought sleep was important to them compared to the other two classes.

Discussion

Research conducted across multiple countries has shown that the timing of bedtime on school nights gets later from late childhood through the second decade of life, leading to shorter sleep duration. The bulk of empirical evidence, however, suggests that sleep *need* does not decline across the same time period (Carskadon 2011). A report from the National Sleep Foundation (2014) found that over half (58%) of parents report that their adolescent (aged 15–17) sleeps 7 h per night or less. Further, adolescent sleep duration may be worsening over time (Keyes et al. 2015). In this context, the goal of the current study was to gain a deeper understanding of the combinations of sleep barriers encountered by youth. We build upon previous research assessing individual sleep barriers (e.g., watching TV, socializing online, schoolwork, noise, light) by using a person-centered approach to examine intra-individual clustering of multiple barriers to sleep. Whereas previous variable-centered approaches have identified a number of factors that negatively affect sleep on average across a sample of youth, our approach allowed us to identify four classes of youth who all report getting less sleep than they need but experience distinct combinations of barriers to their sleep.

Integration and Implications

Our first research question asked how adolescent-reported reasons for poor sleep co-occur within individuals. We found that over half of the youth in our study fit into a class of young people who reported school and screen-related barriers to sleep (i.e., *School/Screens Barriers* class); this finding supports our first hypothesis and is consistent with prior research indicating that homework, extracurricular activities, watching TV, and socializing (especially with friends) are the major barriers to sleep (Gaarde et al. 2018; Noland et al. 2009; Owens et al. 2017). We also found a class (*Home/Screens Barriers*) with the highest frequency of respondents who reported noise in home and neighborhood and second highest frequency of light in the room; these findings partially support Hypothesis 2, that contextual factors (i.e., noise, light) would be interrelated determinants of sleep, as this group also had high levels of screen use (i.e., watching shows, socializing online). Our analyses also revealed two additional classes. Adolescents in the *Minimal Barriers* class were characterized by an extremely low frequency of any barriers. For instance, this group reported less *than half* the levels of the most prevalent adolescent-reported barriers to sleep (i.e., homework, watching shows, and socializing), compared to all other groups. Finally, youth in the *High/Social Barriers* class reported multiple, simultaneous demands on their time across multiple domains and prioritized social activities more than any other group. This may reflect attempts to multitask, a tendency to overcommit, and/or suboptimal time management among members of this group.

Regarding our second research question, exploring characteristics of youth within each of the sleep barrier classes, we found that the *Home/Screens Barriers* class and the *High/Social Barriers* class reported the highest levels of environmental stress, depression, and anxiety.

This class distribution partially supports Hypothesis 3, that youth with higher environmental stress would report more neighborhood/home barriers to sleep; it also supports Hypothesis 4, that youth with high depressive and anxiety symptoms would report more sleep barriers across all categories. Despite similar frequency levels of sleep duration and quality across these two "risky" classes, the *Home/Screens Barriers* class values sleep significantly more than the *High/Social Barriers* class (82 vs. 69% reported that sleep is very important); this implies that their particular barriers may feel less controllable, as discussed in more detail below. The *High/Social Barriers* class, on the other hand, may be prioritizing social activities before sleep, and other daily routines such as eating dinner (98% report eating dinner late) or doing homework (100% report starting homework late), which can have direct effects on bedtimes.

Overall, our results suggest that not all sleep-deprived youth are sleep deprived for the same reasons, and that youth may benefit from different prevention and intervention approaches to improving their sleep based on the type of barriers they face, their background, mental health status (i.e., depressive and anxiety symptoms), and sleep characteristics. For example, the majority of youth who face typical academic and extracurricular barriers but report generally high sleep quality and values (i.e., *School/Screens* class) may benefit from cognitive-behavioral approaches to promote sleep. These students could learn to self-monitor to assess the frequency of problematic sleep practices (e.g., doing homework late at night, watching TV before bed, spending time on social media) and the antecedents and consequences of behavior. For example, the Sleep SENSE intervention (Blake et al. 2016; Waloszek et al. 2015) focuses on tracking behavioral changes and identifying and overcoming barriers for adolescents through motivational interviewing. Youth in the *Home/Screens Barriers*, on the other hand, may have less control over certain aspects of their sleep such as noise and light in their environment.

The *Home/Screens Barriers* class (who reported the shortest sleep duration and worst sleep quality, as well as high levels of neighborhood stress) may be using their phones or televisions as a distraction when home or neighborhood is loud, or even unsafe. Therefore, interventions that focus on individual behavior may have limited or even negative effects, as youth could be frustrated that they cannot change certain aspects of their life that seem out of their control. Indeed, most (82%) of youth in the *Home/Screens Barriers* class thought that sleep was very important, underscoring the uncontrollable nature of their sleep barriers. One straightforward approach to address light and sound barriers would be to distribute low-cost sleep aids (e.g., eye masks, ear plugs). Second, it may be helpful to get parents involved. Noise in the home was the single largest barrier reported in the *Home/Screens Barriers* class; having family members stay up late was also significantly higher than any other classes. It is possible that interactions between youth and their families are especially tense or upsetting late at night, increasing stress and delaying sleep onset. This may be related to previous findings that time spent with family (but not friends) was associated with longer sleep latencies in adolescents (Tavernier et al. 2017). Thus, to the degree to which parents recognize the importance of sleep for their children and for themselves, they may play an important role in reducing controllable ambient noise in the household at night, shifting nighttime activities earlier (e.g., eating dinner, planning for the next day), and reducing stressful conversations before bed.

The National Sleep Foundation (2014) reports that children sleep better when parents establish rules and set limits on technology. This report aligns with the growing literature —mostly from sleep experts and pediatricians—about the importance of set bedtimes and the detrimental link between sleep and electronic devices among school-aged children and adolescents (for a review see Hale and Guan 2015). In our sample, approximately one-third of youth report having either a set bedtime (34%) and/or an electronic curfew (31%). We did not find any significant differences in bedtime rules across the four classes; however, the *Minimal Barriers* class reported significantly higher rates of an electronic curfew and the best sleep (quantity and quality) than any other class. While this could be interpreted as suggesting that electronic curfews should be applied to all youth, it is important to note that the *Minimal Barriers* class was also unique in several other ways: They had significantly fewer barriers across all domains than any other youth in our sample; they also had the highest proportion of boys and Hispanic/Latino respondents, as well as the lowest levels of neighborhood stress and depressive and anxiety symptoms. Therefore, it is possible that interventions that work with families and youth to improve sleep hygiene (e.g., electronic curfew, regular bedtimes) may benefit certain adolescents with a few, moderate barriers and good mental health, but have limited success for others. Programs that target pre-sleep arousal (e.g., sleep-impeding intrusive thoughts) may be especially important for perceived sleep quality for at-risk youth and could be a target for new treatments of adolescent sleep problems for those with mental health problems (Blake et al. 2017). In sum, developmental scientists play an important role in developing a more nuanced understanding of how parental rules, school policies, and potential prevention/intervention programs affect youth by the age and gender of the child, environmental factors, and youth's competing demands.

Strengths and Limitations

Strengths of this study design include a diverse sample of middle and lower income ethnic minority and immigrant youth (primarily from China or Latin America), who have been understudied in the current literature on adolescent sleep in the U.S. despite the fact that racial/ethnic minority youth are at higher risk for poor sleep (Adam et al. 2007; Maslowsky and Ozer 2014). Another strength is that we recruited participants from required high school classes, which helped to minimize selection factors within each school. Additionally, we examined gender and racial/ethnic differences in sleep barriers, which has not been evaluated in previous work. Finally, we took a person-centered approach to studying a wide variety of student-reported sleep barriers (e.g., academic, social, environmental), highlighting important individual factors that may lead to divergent barriers to sleep during adolescence with distinct intervention recommendations.

Several limitations should be noted. All data are self-reported; future research could examine classes of sleep barriers with objective measures of sleep, such as actigraphy. Additionally, future studies should explore additional barriers to sleep that were not covered in our survey (e.g., sharing a room, chores) and new barriers that may emerge in the coming years (e.g., hi-tech games or media), as well as other relevant youth outcomes (e.g., conduct problems, substance use). Further, the sample included a large number of youth whose families immigrated from China and Latin America, however, we did not measure specific cultural determinants of sleep or generational status, which could modify cultural values

related to sleep: a more detailed examination of sociocultural influences on sleep should be investigated in future research. Additionally, the current study does not account for school-level differences (e.g., school start times, extracurricular activities offered at school, amount of homework). School start times, in particular, have gained attention in recent years and represent one important avenue for district or school-level interventions regarding sleep (Minges and Redeker 2016).

Conclusion

This study advances our understanding of the barriers that lead to insufficient sleep in adolescence, a prevalent problem with implications for all aspects of youth development. We used a person-centered approach, latent class analysis, in order to describe categories of co-occurring sleep barriers in a diverse sample of urban youth. Our results identified four distinct classes of youth, who all report getting less sleep than they need, but experience distinct combinations of barriers to their sleep. Two classes appear to be at particular risk for depressive and anxiety symptoms, and reduced sleep quantity and quality; however, they had distinct barriers (i.e., noise/light vs. socializing) and significantly different attitudes towards sleep (i.e., think sleep is more/less important). Insights into how sets of sleep barriers co-occur across diverse groups of students—including those with different sociodemographic backgrounds, mental health experiences, and home environments—can potentially inform the development of more relevant and effective sleep interventions.

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Biographies

Lindsay Till Hoyt is an Assistant Professor of Applied Developmental Psychology at Fordham University. She investigates how biological processes, psychological experiences, and social contexts interact during youth to influence lifelong health trajectories and health disparities, with specific attention to pubertal processes, adolescent sleep, stress biology, and positive youth development.

Julie Maslowsky is an Assistant Professor in the Department of Kinesiology and Health Education at the University of Texas, Austin. She studies the origins, consequences, and prevention of adolescent health risk behaviors. Specific areas of focus include substance use and abuse, teen pregnancy prevention, mental health, and sleep.

Julie S. Olson is a Postdoctoral Scholar at the University of North Carolina Population Center. Her major research interests include population health disparities, adolescence and transition to adulthood, life course and developmental trajectories, and social demography.

Allison G. Harvey is a Professor of Psychology at the University of California, Berkeley. Her research is focused on adult and child psychopathology, particularly sleep disorders, bipolar disorder, major depressive disorder and anxiety disorders, as well as treatment development and behavior change.

Julianna Deardorff is an Associate Professor of Maternal and Child Health and the King Sweesy and Robert Womack Endowed Chair in Medical Science and Public Health at the University of California, Berkeley. Her major research interests include pubertal development, adolescent sexuality and reproductive health, Latina families and health behaviors, stress and coping, and the promotion of positive mental health among children and adolescents.

Emily J. Ozer is a Professor of Community Health Sciences at the School of Public Health, University of California, Berkeley. Her research is centered on school and community-based interventions and community-based participatory research, violence prevention, and the promotion of mental and physical health among adolescents.

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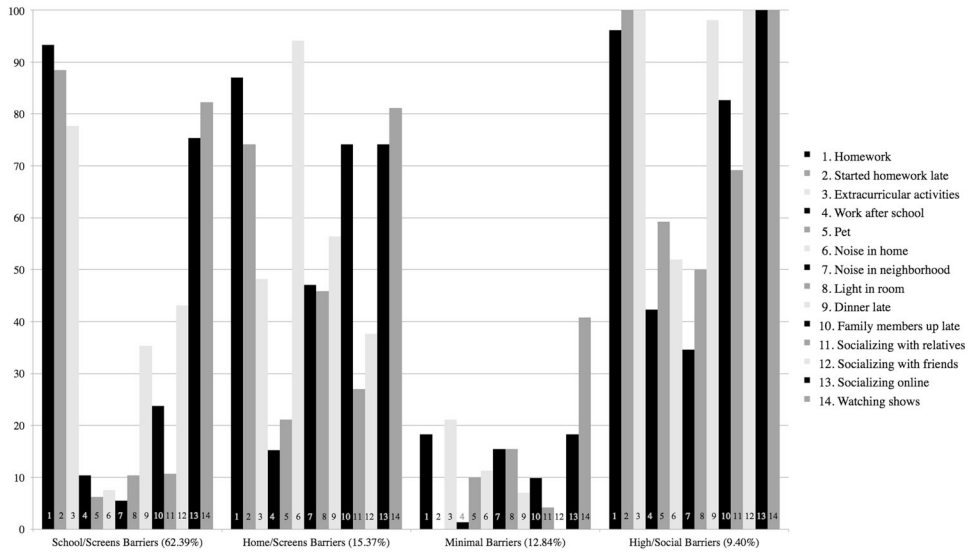

Fig. 1.
Descriptive frequencies of reasons for poor sleep by latent class

Table 1

Fit statistics to determine appropriate number of latent classes, $N = 553$

	1 class	2 classes	3 classes	4 classes	5 classes	6 classes
Loglikelihood	−4063	−3828	−3713	−3668	−3630	−3608
Parameters	14	29	44	59	74	89
BIC	8214	7839	7704	7708	7727	7778
Sample size adjusted BIC	8170	7747	7564	7520	7492	7495
Entropy		0.729	0.805	0.827	0.790	0.806
LMR *p*-value		0.007	0.001	0.055	0.212	0.886

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Table 2

Descriptive statistics of sociodemographic features, mental health, and sleep characteristics by latent class

	Mean (SD) / %					
	Full sample *N* = 553	**School/Screens barriers** *n* = 345 (62.39%)	**Home/Screens barriers** *n* = 85 (15.37%)	**Minimal barriers** *n* = 71 (12.84%)	**High/Social barriers** *n* = 52 (9.40%)	**Between class**
Sociodemographic features						
Age (years)	14.76 (1.06)	14.82 (1.04)	14.95 (1.22)	14.27 (0.68)	14.67 (1.12)	
Female (%)	56.78	59.42[a]	64.71[a]	36.63[b,c,d]	53.85[a]	**
Race/ethnicity						
White/Caucasian (%)	30.97	34.21[c]	17.65[a,d,c]	31.41[c]	30.77[c]	*
Black/African American (%)	4.92	4.39	5.88	7.14	3.85	
Asian American (%)	24.41	23.37[c]	36.47[a,b,d]	17.14[c]	19.23[c]	*
Hispanic/Latino (%)	11.48	9.06[a]	14.12	21.43[b]	9.62	*
Other ethnicity (%)	1.46	1.75	0.00	1.43	1.92	
More than one ethnicity (%)	26.78	26.90	25.88	21.43	34.62	
School differences						
Community school (%)	12.30	8.12[a,c]	17.65[c]	25.35[b]	13.46	**
Comprehensive school (%)	12.30	9.28[a]	14.11	23.94[b]	13.46	**
Magnet school (%)	26.04	29.28[a]	29.41[a]	7.04[b,c,d]	25.00[a]	***
Large comprehensive school (%)	49.37	53.33[c]	38.82[b]	43.66	48.08	
Neighborhood stress	1.76 (.68)	1.65[c,d] (.60)	2.09[a,c] (.72)	1.51[c,d] (.52)	2.26[a,b] (.86)	***
Depressive symptoms	1.02 (.39)	1.01[a,c,d] (.36)	1.18[b,c] (.39)	.75[b,c,d] (.30)	1.19[a,b] (.42)	***
Anxiety symptoms	1.06 (.62)	1.06[b,c,d] (.58)	1.34[a,c] (.63)	.62[a,b,d] (.45)	1.24[a,c] (.71)	***
Sleep characteristics						
Hours of sleep per night	7.09 (1.21)	7.02[c] (1.21)	6.87[c] (1.16)	7.75[a,b,d] (.90)	6.96[c] (1.32)	***
Poor sleep quality (%)	41.53	39.36[a,c,d]	60.00[a,b]	19.72[b,c,d]	56.00[a,b]	***
Think sleep is important (%)	81.60	84.59[a,d]	82.14[d]	75.36[b]	69.23[b,c]	*
Parent set bedtime	.35 (.48)	.36 (.48)	.35 (.48)	.34 (.48)	.24 (.43)	

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	Mean (SD) / %					
	Full sample	**School/Screens barriers**	**Home/Screens barriers**	**Minimal barriers**	**High/Social barriers**	**Between class**
	***N* = 553**	***n* = 345 (62.39%)**	***n* = 85 (15.37%)**	***n* = 71 (12.84%)**	***n* = 52 (9.40%)**	
Parent set electronic curfew	.31 (.46)	.32[a] (.47)	.26[c] (.43)	.44[b,c,d] (.50)	.23[a] (.43)	*

Significant between-class differences tested using ANOVA; Significant class comparisons tested using *t*-tests

[a]Significantly different than Minimal Barriers class

[b]Significantly different than School/Screens Barriers class

[c]Significantly different than Home/Screens Barriers class

[d]Significantly different than High/Social Barriers class

*** $p < .001$

** $p < .01$

* $p < .05$